AMYGDALA $z \mapsto z^2 + c$

A Newsletter of Fractals & $\mathcal{M}$ (the Mandelbrot Set) Issue #29

November 1992

In This Issue...

Lost in the Interior, by John Dewey Jones and Leah Holland, investigates the mystery of why the math says that the iterates of points in the body of $\mathcal{M}$ converge to a single attractor, while a practical experiment says otherwise.

Mieczyslaw Szyszkowicz's *Iterative Processes* takes a close look at the general laws of iteration that produce Julia-type sets, Mandelbrot-type sets, and mixtures of the two.

Rollo Silver's *Glimpses of a Fugitive Universe* is a set of fractal images, available as slides, and soon to be available as extremely high-resolution prints.

Ken Shirriff's *Frequently Asked Questions* is an adaptation of the frequently asked questions (FAQ) file for the Usenet newsgroup alt.fractals, where it is posted every two weeks. It is based on the version posted to FRAC-L on September 7, 1992.

Dimension of the Boundary of the $\mathcal{M}$-Set reports Mitsuhiro Shishikura's important mathematical discovery that the dimension of the boundary of $\mathcal{M}$ is exactly 2.

The Slides (S29)

A35 This image by John Dewey Jones dates back to 1986 and was featured in Amy #3. Jones wrote of this image, which he called *Cran's Zard*:

"Slide 35 is of the quasi-Mandelbrot set obtained from $z_n = z_{n-1}^{2.5} + c$. The viewing area is the 3x2 box centered on the origin. The slide shows the strange results typical of non-integer values for the exponent: fractal curves very similar to those for the nearest integral k, but with lines of discontinuity running through them like shock waves. These discontinuities are also reproduced on smaller scales."

The editor continued:

These "fracture lines" are probably the result of the multi-valuedness of $z^{2.5}$. For integer exponents, z^n has a unique value for each z, but not so for non-integer exponents — for example $(-1)^{2.5} = (-1)^2(-1)^{0.5} = \pm i$, so we have two "branches" for the function. Unless the computer program deals carefully with multivaluedness, we may well find adjacent sets of pixels whose values are computed using different branches of the function, resulting in these "fracture lines" of discontinuity between the sets.

This is discussed in more detail under **BIFURCATIONS** (See Amygdala #3, pp 1-2).

A37 (John Dewey Jones). "Slide 37 is a 100,000-fold magnification of a miniature Mandelbrot set on the proboscis of the full-size set. I was struck by the progressive increase in the figure's lines of

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symmetry as one moves from the periphery towards the set in the center — this suggests analogies with many things, for example the increase in the period of oscillations in Verhulst populations until chaos sets in[1]."

"The picture's coordinates are $-1.99641 - 0.000024i$ (lower left) and $-1.99635 + 0.000024i$ (upper right). The iteration used was $z \to z^2 + c$, with a limit of 1000 iterations."

This image first appeared with Amygdala #2.

A165 (John Dewey Jones). "Interior of $\mathcal{M}$ — A mystery." This mystery is explained in *Lost in the Interior*, below.

A2506 is by Ian Entwistle.

Lost in the Interior

John Dewey Jones and Leah Holland
School of Engineering Science,
Simon Fraser University

$\mathcal{M}$ consists of those points which don't go to infinity as we perform the Mandelbrot iteration on them. This invites the question: "Where do they go, then?" In *Polar Coordinates and the Cardioid Body of $\mathcal{M}$* (Amygdala #21), Ralph Walde writes that the points in the body of $\mathcal{M}$ go to a single attractor, namely zero, while points in the head go to an attracting cycle of length two; points in other protuberances on the set go to other attracting cycles of greater length.

In Amy #19, the Philip brothers observe that the attracting cycle of the points within a protuberance (or 'atom', to use their terminology) can be read off from the number of rays in the star attached to the tip of the atom. This is very helpful if one has a global image of the set available but it would also be nice to have a *local* method of determining cycle length.

We could modify our Mandelbrot-generating algorithm to detect convergence to an attractor or attracting cycle rather than just checking when a point is headed off to infinity. Then we could colour in the point according to the length of its attracting cycle, and we should have a picture of $\mathcal{M}$ colour-coded by cycle length.

Here's the pseudocode for such an algorithm; we've written the pseudocode using complex numbers, but it's easy enough to break it down into operations on the real and imaginary parts if your compiler doesn't support complex numbers:

```
for i = 1 to maximumNumberOfIterations
    if not converged then
        z(i) = z(i-1)**2 + z(0)
        for j = i-1 to 0, counting backwards,
            if distance(z(i),z(j))<= ε then
                cycleLength = i - j
                converged = true
```

We should also include the test for z going off to infinity, but we've left it out for brevity. Running this algorithm produced the result shown below in Figure 1.

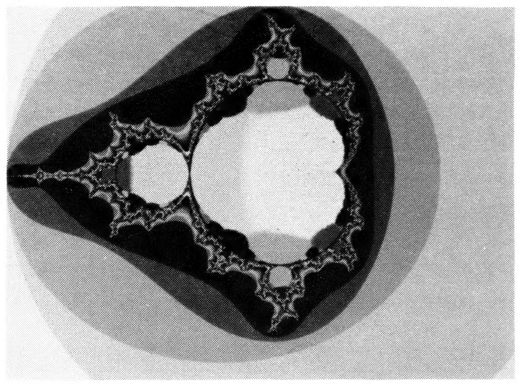

Figure 1— Interior of $\mathcal{M}$ with Strange Cycle Regions

But this result is not what we expected: although most of the body appears to have cycle length one, there is a region adjacent to the head — call it the 'shoulders' — which is shown to have cycle length two. There is a strange, fingerprint-like zone between the two regions.

So which is right, Figure 1 or Ralph Walde? To see what is happening more clearly, let us consider a series of real numbers converging to a point (Figure 2; next page).

Figure 2 resembles a plot of damped harmonic oscillations. A periodic oscillation is occurring within an envelope, and the envelope itself is shrinking to a single point. We could say there are two types of convergence in the figure: the odd-

1. See e.g. *The Beauty of Fractals*, pp 23-26. *RS*

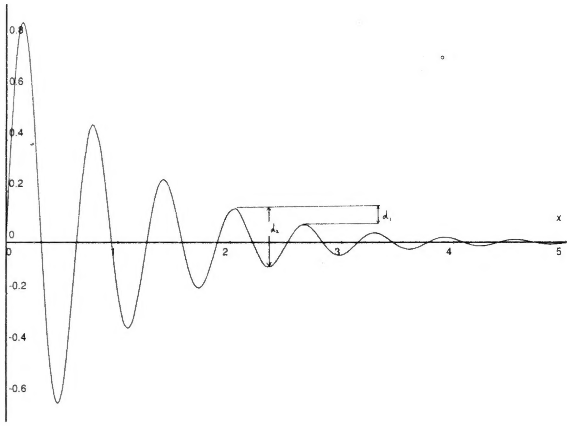

Figure 2— Damped Oscillation

numbered points in the sequence are converging to the upper edge of the envelope and the even-numbered points are converging to the lower edge; meanwhile, the two edges are themselves converging to a single point.

Although the series is converging to a single attractor, the distance d_1 between alternate points is always smaller than the distance d_2 between successive points. As our algorithm compares d_1 and d_2 to the pre-set limit ε, it will therefore detect a cycle of length 2 as soon as $d_1 \leq \varepsilon$, and will never go on to discover that the two attracting points of the cycle are actually a single point. (This example deals with an apparent cycle of length 2, but its extension to cycles of other lengths should be obvious.)

This is an easy trap to fall into, as evidenced by the fact that we've fallen into it twice ourselves; image A165, created in December 1986 and distributed in the current slide set, #29, displayed the same 'fingerprint' pattern. How can we avoid it?

A non-rigorous but effective test is as follows: suppose we have set a threshold ε in the test for which the pseudocode was given above. Then the edges of the envelope are approaching fixed values in steps whose size is bounded above by ε. So if the edges are, say, $N\varepsilon$ apart, where N is the upper bound on the number of iterations, we wouldn't expect them to come together before we've reached the limit of the number of iterations.

So, after we've detected an apparent cycle of length l at a threshold ε, we should examine the previous $l-1$ points and see if any of them is within $N\varepsilon$ of the current point. If none is, then we can be reasonably confident that we have a genuine cycle of length l. Otherwise we reset ε to a tenth of its current value and try again. The pseudocode for this modified method is given below.

```
for i = 1 to N
    if not converged then
        z(i) = z(i-1)**2 + z(0)
        for j = i-1 to 0, counting backwards,
            if distance(z(i),z(j)) <= ε then
                cycle = true
                for k = j+1 to i-1
                    if d(z(i),z(k)))<= Nε then
                    cycle = false
                if (cycle) then
                    cycleLength = i - j
```

Figure 3 shows the result from the modified code.

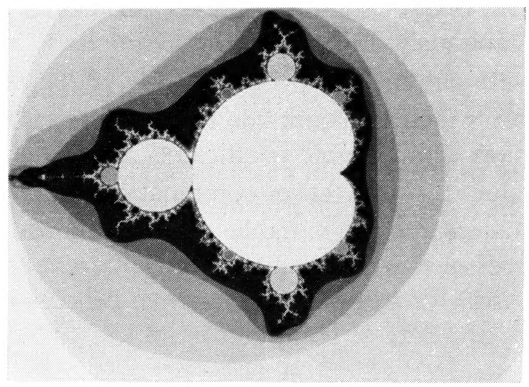

Figure 3— Interior of $\mathcal{M}$ with Correct Cycle Regions

Iterative Processes

— Mieczyslaw Szyszkowicz

Many computer images illustrate the behavior of the sequence $\{z_n\}$, defined by the iteration

$$z_{n+1} = \Phi(z_n),\ n = 0, 1, 2, \ldots$$

where z_0 is a given initial value. The iterative function Φ defines the recurrence process. The function Φ depends on the parameters and variables. The behavior of the sequence $\{z_n\}$ depends strongly on these parameters and their interpretation. Three variations are possible.

Type I. The behavior of the sequence $\{z_n\}$ is considered as a function of the initial value z_0. This

approach produces the Julia sets. The iteration

$$z_{n+1} = z_n^2 + c \tag{1}$$

or the iteration derived from Newton's method applied to find a zero of a function f:

$$z_{n+1} = z_n - \frac{f(z_n)}{f'(z_n)}$$

are good examples of such methods [Man82], [Pei88].

Type II. The sequence $\{z_n\}$ is a function of the right-hand side of the iterative equation. The Mandelbrot set is generated by such a method. In this case the iteration (1) is executed with $z_0 = 0$ and variable c. The iterative function Φ depends on the value of c.

Type III. Both of the previous approaches are used simultaneously. In [Szy90a] the iteration (1) is studied with variable z_0 and c. Similarly, in [Szy90b] Newton's method is applied to solve the cubic equation with variable coefficients and variable initial value z_0. Many other combinations of the parameters and the variables may be introduced. Mixtures of these three types and different criteria (millions!) for stopping the iterative process result in a rich variety of computer graphics.

The following figures illustrate the three variants of the iterative process derived from Euler's method. The Euler method is used to solve the following system of ordinary differential equations:

$$\frac{dx}{dt} = \sin ay,$$

$$\frac{dy}{dt} = \sin bx.$$

Type I: a = b = 1; the initial values $x_0, y_0 \in [-5, 5]$ (see Figure 4).

Type II: $a, b \in [-5, 5]$, $x_0 = 1$, $y_0 = -2$ (see Figure 5).

Type III: $a, b, x_0, y_0 \in [-5, 5]$ (see Figure 6).

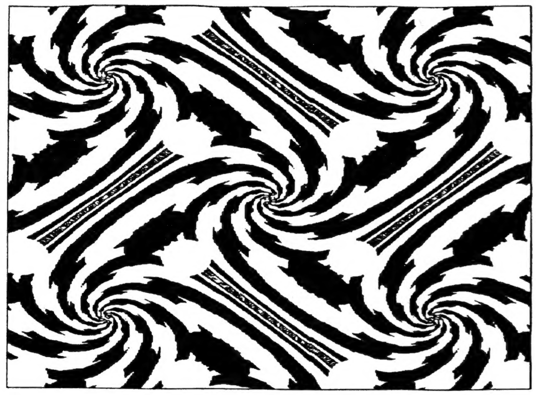

Figure 4— Euler's Method, Type I

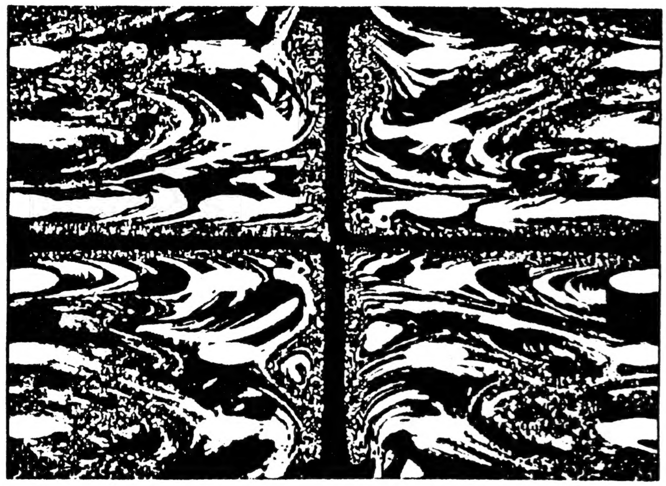

Figure 5— Euler's Method, Type II

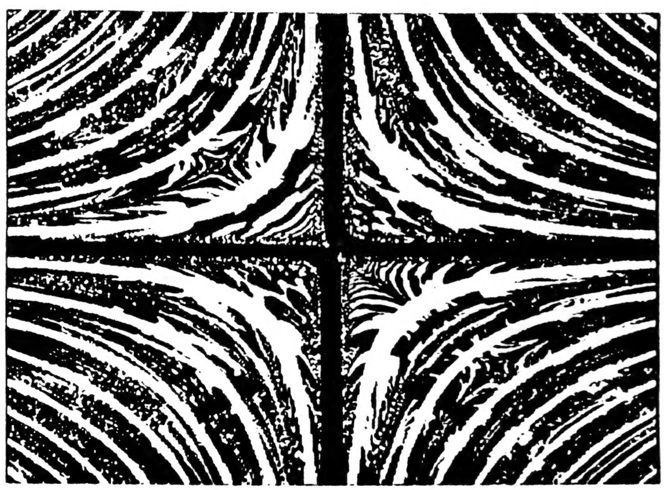

Figure 6 — Euler's Method, Type III

References

[Man82] B.B. Mandelbrot, *The Fractal Geometry of Nature,* W.H. Freeman & Co., New York (1982).

[Pei88] H.-O. Peitgen, D. Saupe [Editors], *The Science of Fractal Images,* Springer-Verlag New York (1988).

[Szy90a] M. Szyszkowicz, *The Mandelbrot Set and the Julia Sets,* (submitted to Recreational and Educational Computing).

[Szy90b] M. Szyszkowicz, *The Cubic Equation and Newton's Method,* (submitted to Recreational and Educational Computing).

Glimpses of a Fugitive Universe

Glimpses of a Fugitive Universe (GFU) is a set of 12 fractal fine art images created by Rollo Silver:

1. *Seahorse Quadrille*
2. *Vader's Heart*
3. *Almondala*
4. *Unicellular Broccolus*
5. *Eckhart's Eyes*
6. *Bird of Paradise*
7. *Firebird*
8. *The Hound of the Hedges*
9. *Strawberry Quadrille*
10. *Strawberry Fields Forever*
11. *Syzygy*
12. *Bonsai*

They are currently available as a set of 12 color slides, at a uniform resolution of 1024 × 683 pixels. There is a catalogue and brochure for the set. For prices see the current Price List / Order Form.

These images will be available as Cibachrome prints in a variety of sizes, mounted and laminated for optimum archival quality: 10" × 8", 14" × 11", and 20" × 16" are standard.

Larger sizes will be available on special order, as well as box-mounted, back-lit translucencies.

I've been doing my Cibachrome prints from 35mm slides having a resolution of 2048 × 1366 pixels, but I will use 4096 × 1366 pixels for the GFU prints up to 20" × 16". This resolution pushes *beyond* the capacity of 35mm film, and the resulting images will have truly astonishing fractal detail.

If I can handle the enormous files involved I will produce 5" × 4" film transparencies of 8192 × 6144 pixels, and make large Cibachrome prints from them: from 30" × 24" on up to six foot by four foot murals.

A six foot by four foot backlit translucency with 8K resolution: a truly awesome sight! I will make these prints on special order, and interested parties should contact me directly.

Frequently Asked Questions

— *Ken Shirriff*

This is an adaptation of the frequently asked questions (FAQ) file for the Usenet newsgroup alt.fractals, where it is posted every two weeks. It is the version posted to FRAC-L on September 7, 1992.

A copy of the FAQ is archived at various places such as:

pit-manager.mit.edu [18.72.1.58]:
/pub/usenet/news.answers/fractal-faq

and

ftp.uu.net [137.39.1.9 or 192.48.96.9]:
/usenet/news.answers/fractal-faq.Z

I am happy to receive more information to add to this file. Also, if you can correct mistakes you find, let me know. Remember, this file depends on your feedback and contributions.

Please send additions, comments, errors, etc. to Ken Shirriff (shirriff@sprite.Berkeley.EDU).

The questions which are answered are:

Q1: What is FractInt?

Q2: Where can I obtain other software packages to generate fractals?

Q3: What if I can't use FTP to access files?

Q4: Where is alt.fractals.pictures archived?

Q5: I want to learn about fractals. What should I read first?

Q6: The Mandelbrot set.

Q6a: What is the Mandelbrot set?

Q6b: How is the Mandelbrot set actually computed?

Q6c: Why do you start with $z = 0$?

Q6d: What are the bounds of the Mandelbrot set? When does it diverge?

Q6e: How can I speed up Mandelbrot set generation?

Q6f: What is the area of the Mandelbrot set?

Q6g: What can you say about the structure of the Mandelbrot set?

Q6h: Is the Mandelbrot set connected?

Q7: Julia sets.

Q7a: What is the difference between the Mandelbrot set and a Julia set?

Q7b: What is the connection between the Mandelbrot set and Julia sets?

Q7c: How is a Julia set actually computed?

Q8: Complex and quaternion arithmetic.

Q8a: How does complex arithmetic work?

Q8b: How does quaternion arithmetic work?

Q9: Iterated Function Systems.

Q9a: What is an iterated function system (IFS)?

Q9b: What is the state of fractal compression?

Q10: How are fractal mountains generated?

Q11: What are plasma clouds?

Q12: Lyapunov exponents.

Q12a: Where are the popular Lyapunov fractals described?

Q12b: What are Lyapunov exponents?

Q12c: How can Lyapunov exponents be calculated?

Q13: What is the logistic equation?

Q14: What is chaos?

Q15: What is nonlinearity? What are nonlinear equations?

Q16: What is a fractal? What are some examples of fractals?

Q17: What is fractal dimension? How is it calculated?

Q18: What is a strange attractor?

Q19: How can I join the BITNET fractal discussion?

Q20: How can 3-D fractals be generated?

Q21: What are some general references on fractals and chaos?

Questions and Answers

Subject: FractInt

Q1: What is FractInt?

A1: FractInt is a very popular freeware (not public domain) fractal generator. There are DOS, Windows, OS/2, and UNIX/X versions.

The DOS version is the original version, and is the most up-to-date.

The UNIX version is still somewhat buggy.

Please note: alt.fractals is not a product support newsgroup for FractInt. Reports of bugs in FractInt/xFractInt should usually go to the authors rather than being posted.

FractInt is on many ftp sites. For example:

DOS: ftp to wuarchive.wustl.edu [128.252.135.4]
The source is in the file
/mirrors/msdos/graphics/frasr172.zip
The executable is in the file
/mirrors/msdos/graphics/frain172.zip

Windows: ftp to wuarchive.wustl.edu
The source is in the file
/mirrors/msdos/windows3/winfr171.zip
The executable is in the file
/mirrors/msdos/windows3/winsr171.zip

OS/2: available on Compuserve in its COMART forum in Library 12. The files are PM*.ZIP. These files are also available from
ftp-os2.nmsu.edu in /pub/os2/pmfract.zoo
and from
hobbes.nmsu.edu.

UNIX: ftp to
sprite.berkeley.edu [128.32.150.27]
The source is in the file
xfract105.shar.Z

Note: *sprite* is an unreliable machine; if you can't connect to it, try again in a few hours, or try
hijack.berkeley.edu.

For European users, these files are available from
ftp.uni-koeln.de

If you can't use ftp, see the mail server info in Q3.

Subject: Other Fractal Software

Q2: Where can I obtain other software packages to generate fractals?

A2: For X windows:
xmntns and xlmntn: these generate fractal mountains. They can be obtained from ftp.uu.net in the directory

/usenet/comp.sources.x/volume8/xmntns

xfroot: generates a fractal root window.

xmartin: generates a Martin hopalong root window.

xmandel: generates Mandelbrot/Julia sets. xfroot, xmartin, xmandel are part of the X11 distribution.

lyap: generates Lyapunov exponent images. Ftp from: ftp.uu.net in

/usenet/comp.sources.x/volume16/lyap

Distributed X systems:

MandelSpawn: computes Mandelbrot/Julia sets on a network of machines. Ftp from: export.lcs.mit.edu:
/contrib/mandelspawn-0.06.tar.Z

or funic.funet.fi:
/pub/X11/contrib/mandelspawn-0.06.tar.Z

gnumandel: computes Mandelbrot images on a network. Ftp from:
informatik.tu-muenchen.de [131.159.0.110] in
/pub/GNU/gnumandel

For UNIX/C:

lsys: generates L-systems as PostScript or other textual output. No graphical interface at present (in C++). Ftp from: ftp.cs.unc.edu in
pub/lsys.tar.Z.

lyapunov: generates PGM Lyapunov exponent images. Ftp from: ftp.uu.net in
/usenet/comp.sources.misc/volume23/lyapuov
SPD: contains generators for fractal mountain, tree, recursive tetrahedron. Ftp from: princeton.edu [128.112.128.1] in /pub/Graphics

For Mac:

fractal, L-System, 3DL-System, IFS, FracHill are available from ftphost.aukuni.ac.nz [130.216.1.5] in the architec directory.

fractal-wizard-15.hqx, julias-dream-107.hqx, mandel-julia-10.hqx, mandel-zot-304.hqx, mandel-zot-304-extensions.hqx, mandel-zot-lyapunov-ext.hqx, mandel-zot-304-docs.hqx, mandelbrot-10.hqx are available from sumex.stanford.edu in
/info-map/app

mandel-tv: a very fast Mandelbrot generator. Ftp from: uhunix2.uhcc.hawaii.edu [128.171.44.7] in
/pub/mac/da/mandel-tv.hqx

Mandella: a fractal generator drawing over 60 fractals. Ftp from: sumex-aim.stanford.edu in
/info-mac/demo/Mandella-606d6.hqx

For NeXT:

Lyapunov: generates Lyapunov exponent images. Ftp from: nova.cc.purdue.edu in
/pub/next/2.0-release/source

For MSDOS:

Fractal WitchCraft: a very fast fractal design program. Ftp from: garbo.uwasa.fi in
/pc/demo/fw1-08.zip

CAL: generates 15 types of fractals including Mandelbrot, Lyapunov, IFS, and user-defined formulas. Ftp from: oak.oakland.edu (or any other Simtel mirror) in
pub/msdos/graphics/frcal030.zip

There is an archive site for preprints and programs on nonlinear dynamics and related subjects at lyapunov.ucsd.edu [132.239.86.10]. There are also articles on dynamics, including the IMS preprint series, available from
math.sunysb.edu [129.49.31.57].

Please inform me (Ken Shirriff) of any other programs you know of.

Subject: Ftp mail server

Q3: What if I can't use FTP to access files?

A3: If you don't have access to FTP because you are on a uucp/Fidonet/etc network there is an e-mail gateway at ftpmail@decwrl.dec.com that can retrieve the files for you. To get instructions on how to use the FTP gateway send a blank message to ftpmail@decwrl.dec.com with one line containing the word 'help'.

This is a sample message of how to retrieve xFractInt from sprite.Berkeley.EDU:

% mail ftpmail@decwrl.dec.com

```
Subject: <ignored>
reply <yourname>@<yoursite>
connect sprite.berkeley.edu anonymous
dir
binary
uuencode /* note: this command is optional and the
   default is btoa */
get xfract105.shar.Z
quit
```

That would retrieve a directory of the archive, then xfract105.shar.Z. To receive xfract105.shar.Z, you must set the server to 'binary' mode because the file is compressed. Compressed files are then either sent out uuencoded or btoa'd. So, you must obtain copies of the programs uudecode (or atob) and 'uncompress' to unpack the files that you will receive. (Most UNIX systems have uudecode and uncompress.) Ask your local computer guru for clarification on how to do this.

Subject: Archived pictures

Q4: Where is alt.fractals.pictures archived?

A4: Alt.fractals.pictures is the newsgroup for fractal images (GIFs, etc.). The pictures are available via anonymous FTP from csus.edu [130.86.90.1] in

/pub/alt.fractals.pictures

Subject: Learning about fractals

Q5: I want to learn about fractals. What should I read first?

A5: There is a book list at the end. *Chaos* is a good book to get a general overview and history. *Fractals Everywhere* is a textbook on fractals that describes what fractals are and how to generate them, but it requires knowing intermediate analysis. *Chaos, Fractals, and Dynamics* is also a good start.

Subject: The Mandelbrot set

Q6a: What is the Mandelbrot set?

A6a: The Mandelbrot set is the set of all complex c such that iterating $z \leftarrow z^2 + c$ does not go to infinity (starting with $z = 0$).

Q6b: How is the Mandelbrot set actually computed?

A6b: The basic algorithm is:

For each c, start with $z = 0$. Repeat $z \leftarrow z^2 + c$ up to N times, exiting if the magnitude of z gets large. If you finish the loop, the point is probably inside the Mandelbrot set.
If you exit, the point is outside and can be colored according to how many iterations were completed. You can exit if $|z| > 2$, since if z gets this big it will go to infinity. The maximum number of iterations, N, can be selected as desired, for instance 100. Larger N will give sharper detail but takes longer.

(To be continued)

Author

Ken Shirriff is currently a Ph.D. graduate student in operating systems at the University of California, Berkeley. He is interested in the mathematical analysis of fractal structure, was responsible for the Unix port of the Fractint program, and is active on the Usenet newsgroup sci.fractals. He can be reached by electronic mail at:

shirriff@cs.berkeley.edu

Dimension of the Boundary of the $\mathcal{M}$-Set

Dave Uherka, of the Math department, University of North Dakota, posted the following note on the FRAC-L conference:

"The July issue of SIAM News (Society of Industrial and Applied Math) has an article by Barry Cipra (page 22) on recent results about the Mandelbrot Set. He says that it has just been proved by a Japanese mathematician, Mitsuhiro Shishikura, currently at SUNY/Stony Brook, that the Hausdorff dimension of the boundary of the Mandelbrot Set is 2. That implies that the usual 'fractal dimension' is also 2, since the fractal dimension as defined in Barnsley's *Fractals Everywhere* is greater than or equal to the Hausdorff dimension. It had been previously stated on this list (FRAC-L) that Mandelbrot has conjectured that the $\mathcal{M}$ Set has dimension 2, but I don't recall seeing an announcement of the proof prior to now. Cipra does not give a reference for Shishikura's proof."

An Apology

Steve Stoft's *Synchronous Orbits* (see Amygdala #26) appears to be a novel and powerful algorithm for speeding up calculations involving iteration, as well as a program embodying it. The algorithm seems promising, although it may be improved by some modifications. In any case, the "returns" are not yet in. Both Tim Wegner (*FractInt*) and Dave Platt (*MandelZot*) intend to incorporate Steve's algorithm into their programs -- or perhaps a variant of the algorithm that I suggested to each of them, involving triangular subdivision rather than rectangular subdivision, and a more subtle criterion of when to subdivide.

The *Fractal Witchcraft* program is another matter. Leonard Herzmark had problems with its documentation; Dan Lufkin was apparently able to overcome the difficulties and get the program to perform; so I'd say the issue is in doubt.

I've gotten into trouble before by publishing materials having a significant content of the author's feelings. I've apparently offended both Leonard and Steve with my sloppy handling of *Synchronous Orbits* and *Fractal WitchCraft*. I assumed incorrectly that Leonard's letter, which I published in Amygdala #26, was in effect a review of the program, and that's why I published it.

I do apologize to both Steve and Leonard for my carelessness.

I hope that Leonard's new letter, reprinted below, is now the last word, and is not the prelude to more controversy. With it I hope to terminate the "personal" aspects of this matter.

September 26, 1992

Rollo,

I am completely puzzled and more than a little angry, and I believe you owe Steve Stoft and me an apology. The letter that I sent you with regards to the problems I was experiencing with his program was never intended as a review of the program. As noted, it was my first reply to your rush, rush request for a review. That was followed by a call from you, stating that I should disregard the urgent nature of the request, and that you would go ahead with releasing that edition of Amy. That was, I believe, in February of this year. I received that edition when I picked up my mail on September 8, having been gone since August 10. To refresh your memory, you did contact Stoft after our conversation, and he called me to discuss the problems with the documentation. I told him, at that time, that I had followed his written documentation explicitly, but was unable to get many of the functions to operate. Because of ambiguities that existed, he stated that in future he would be more precise in his instructions. He then sent me both a revised program and new written instructions. I phoned him a couple of times (at my expense) to ask for clarification of certain points that still were unclear to me.

I told him that I was sending him a disk of the results (which I did) to determine what the errors were. Stoft did not have the courtesy to reply, so after waiting about three months, I figured the subject was closed and I destroyed my files on the subject. His acrimonious response to the AMY article certainly was uncalled for, particularly in view of the fact that he had failed to respond to my request to him for additional information. Your publication of my letter to you came as a complete surprise. I did not, in any manner, indicate to you that the letter was my review; it was merely a personal communication regarding my initial experience.

I can count as evidenced by my Professional Engineering Registration, my many years of engineering practice, and the fact that my check book does balance with the bank. I know big numbers from little ones!

I hope that you will publish this along with your apologies.

Leonard E. Herzmark

Letter

— *Hans Havermann*

Last night, channel-hopping, I tripped over a British (Thames Television) production called 'Capital City'. This series appears to do for a London brokerage firm what 'L.A. Law' and 'St. Elsewhere' have done for *their* respective professions. In this particular episode, on of the subplots dealt with a creative computer whiz's attempt to introduce 'chaos theory' into marketplace analysis. He

appeared to have some success in using the 'Lorenz Attractor' to predict the future of a particular stock issue: the wings of the butterfly represented (apparently) the 'up' and 'down' phases of the stock's performance.

For me, the highlight of the show came when we were treated to a television monitor displaying the Mandelbrot Set. In front, our mathematical antihero marvels, "Every dot on the screen represents 250 different equations!". But, in spite of such obvious brilliance, our genius manages to assert some incorrect predictions, gets knocked off the corporate ladder, and otherwise alienates the true business elite, who play their hunches less cerebral and more limbic ... as, one must assume, do this T.V. series' viewers.

Two years ago, Alan Davis, writing in 'The Ontario Skeptic' (Vol.3 No.2), noted that "chaos... is new and counter-intuitive, or at least non-intuitive. Yet it is simple enough in some respects to make half-truths easy to express convincingly. That makes for ready exploitation." 'Nuff said.

First Class Mail

When I discovered that one subscriber received newsletter #26 five weeks after I mailed it I realized that third class mail — which I use to send the newsletter to subscribers in the U.S. — is limited!

The difference between first & third class postage is only 32¢ per issue, so I've decided to convert over. Under this system you should get your copy of the newsletter in 2-3 days after I mail it.

You've noticed, perhaps, that this issue is dated "November 1992", where #28 was dated "August 23, 1992". The August date was when I finished the camera-ready copy for issue #28, while the November date is when I expect #29 to be in the hands of you readers.

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Email: rsilver@lanl.gov Phone: 505/586-0197

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Book Reviews Wanted

If you run across a book on the subject of fractals, etc. that seems particularly illuminating, and has not yet been reviewed in Amygdala, think about writing a review of the book and sending it in for possible publication in Amygdala.

Submitting Articles

Here are some guidelines for submitting articles for publication in Amygdala.

1. Type your article as you would like to see it appear in the newsletter. Please do not send handwritten drafts!

Send it (*my* order of preference): (A) On 3.5" diskette in Macintosh format for FrameMaker, MacWrite, WriteNow, or MS Word; or as a text file. Please also enclose paper copy so I can see your intent. (B) On 3.5" diskette in IBM format, text file. I have no way to deal with 5.25" diskettes. (C) Paper copy.

2. Illustrations should be either greyscale (suitable for halftoning) or black/white; not color! (A) Normally, illustrations will be printed in full column width, so you should make them 3.25" wide, if possible — provided that they're 300 dpi resolution. If they're grainier, make them larger if possible, so that they'll look good when reduced to 300 dpi. (B) Make sure that you clearly indicate which illustrations go where in the text! (C) All in all, it's better not to have captions welded into your pictures. Let me put them in ad lib. (D) I can handle illustrations on diskette in MacPaint, MacDraw, CricketDraw, Photoshop, or Adobe Illustrator formats.

3. Please send along a short biographical note, which I will try to publish in the same issue as your article.

4. Please include your telephone number, in case I have to reach you in a hurry with questions.

Circulation

As of October 25, 1992, Amygdala has 480 subscribers, 152 of whom have the supplemental color slide subscription.